AGRONOMY SCIENCE AND BIOTECHNOLOGY

RESEARCH ARTICLE

Cutting management of dual purpose wheat and implications on seed quality

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ABSTRACT

The nutritive value of a dual purpose forage, its structural and morphological composition, seed production capacity are determining characteristics in the selection of a genotype. The objective of this work was to evaluate the effect of cutting management on yield components, physiological quality of the seeds in the subsequent generation. Experiment I: the field cutting management was performed, and the yield components and the physiological quality of the seeds were evaluated. Experiment II: where the components of plant yield and physiological quality of the seeds were evaluated. The cutting managements affect the components of yield, such as thousand seed weight and seed mass per cob, as well as germination, first germination count and seedling dry mass of dual purpose wheat. In the generation that evaluates the quality of the seeds produced, the cuts do not influence the physiological quality of the seeds, however, they affect the yield components, number of cobs per plant, one thousand seed weight and seed mass per cob.

Keywords: *Triticum aestivum* (L), physiological quality of seeds, forage production, germination, physiological stress, grain yield components.

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INTRODUCTION

The dual purpose wheat (*Triticum aestivum* L.) presents high phytomass accumulation, high tillering potential, rapid field establishment, long vegetative phase and short reproductive period, tolerance to trampling and to cut management (Carvalho et al., 2015). It allows the farmer to maximize the productive area, being able to use it in grazing with animals during the winter period and still harvest seeds. However, the forage area is currently considered important for the species cultivation, and seed production is secondary.

The crop-livestock integration in the south of Brazil is used as a rotation alternative for winter cereals, with the purpose of efficient land use, diversification of the rural property, risk reduction and improved soil fertility, with the accumulation of organic matter and cycling of nutrients (Santos et al., 2013). Another important factor related to dual purpose wheat is the supply of pasture with higher nutritional quality, due to the irregularity of forage production in the cold season, leading to a decrease in milk and meat production (Martin et al., 2010).

Worldwide, wheat is among the main cereals grown and ranks third in production volume (Zanonet al., 2012). In the south region of the country, this crop is important to the winter period, where Rio Grande do Sul and Paraná represent 90% of the total volume of Brazilian wheat produced, due to its high adaptability to these regions. Rio Grande do Sul is the second largest producer of Brazilian wheat, with a cultivated area of 1,140,000 hectares, a production of 1,516,000 tons and average productivity of 1,330 kg ha^{-1}. However, dual purpose wheat shows productivities between 1,588 to 4,154 kg^{-1}, varying between cut numbers (Bartmeyeret al., 2011).

The nutritive value of a dual purpose forage, its structural and morphological composition, seed production capacity are determining characteristics in the selection of a genotype. In the literature, there are studies that report the importance of dual purpose wheat, such as its mineral composition, physiological and morphological characters in response to the number of cuts (Meinerzet al., 2011), nutritional value (Zanonet al., 2012), as well as the influence of management practices on plant physiology and morphology (Martin et al., 2010).

Seeds of some forage species, in general, are considered by-products of grazing (Lopes & Granke, 2011). They can show continuous flowering, a short interval between full flowering and abscission of the seeds, which makes harvest difficult (Lopes & Granke, 2011). The susceptibility of the crop to abiotic factors such as rain, hail and frost occurring during the winter period in the southern region of Brazil can affect the handling of dual purpose wheat, mainly to the number of cuts, seed production and/or grains. The number of cuts may influence plant performance, as well as effects on yield components and seed quality (Martin et al., 2010). The knowledge about the plant response to cutting management can contribute to the improvement of cultivation techniques for the production of higher quality seeds in order to obtain high production for dual purpose wheat.

The cutting management of dual purpose wheat may lead to a reduction in yield components, such as number of spikelets, spike and seed mass, as well as grain yield (Martin et al., 2010), and reduce seed vigor (Rodolfo et al., 2017). In this way, the objective of this work was to evaluate the effect of cutting management on yield components, physiological quality of the seeds in the subsequent generation.

MATERIAL AND METHODS

The work was carried out in two stages, in the first one (Experiment I), the field cutting management was performed, and the yield components and the physiological quality of the seeds were evaluated. In the next harvest, seeds were sown in pots, using the seeds produced by the plants submitted to the cuts (Experiment II), where the components of plant yield and physiological quality of the seeds were evaluated.

Experiment I

The first part of the experiment was carried out in 2012 and 2013 in the experimental area belonging to the laboratory of breeding and plant production of the Federal University of Santa Maria, Campus Frederico Westphalen - RS, under coordinates of 27°39'S and 53°42'W and altitude of 490 meters. The climate of the region is characterized by Köppen as humid subtropical Cfa and soil classified as ferric aluminiclatosol (Alvares, Stape, Sentelhas, Gonçalves, & Gerd, 2013).

Experimental design and management used

The experimental design was a randomized block design, organized in a factorial scheme, with four cutting managements (absence, first, second and third cut) and two years of cultivation, arranged in three replications. The experimental units consisted of 12 sowing lines spaced 0.17 meters and two meters long. The cuttings were performed when the plants reached 0.3 m in height, leaving 0.10 m high for regrow (Martin et al., 2010). The direct sowing system was used and the soil fertility correction was carried out based on the previous chemical analysis and according to the Manual of Fertilization and Liming for the States of Rio Grande do Sul and Santa Catarina (CQFS RS/SC, 2004). The control of insects and diseases was also carried out in a preventive manner according to the recommendation of the crop.

The evaluations were based on the proposal by Martin et al. (2010), evaluating the genotypes in the central lines of each experimental unit, disregarding 0.5 meters from each end.

Measured characters

For yield components evaluation, ten plants of each experimental unit were evaluated. The evaluated traits were: seed mass per cob (SMC), and later the accomplishment of the thousand seed weight (TSW). Afterwards the samples were taken to the germination chamber of the BOD type, where the germination (G) was carried out; first germination count (FGC) on the fourth day; seedling dry mass (DM) weighed with a precision scale and the results expressed in g.

For the germination, four samples were used with four subsamples of 50 seeds of each treatment, where the seeds were arranged in sheets of germination paper, moistened with 2.5 times the dry substrate mass. The rolls were kept in a germination chamber of the BOD type at a temperature of 20°C and a photoperiod of 12 hours, counting at seven days after sowing. The first germination count was performed together with the germination test, evaluating the percentage of normal seedlings expressed as a percentage at four days after sowing (Brasil, 2009).

Seedling dry mass determination was obtained by the collection of four subsamples of 10 seedlings per treatment, at 8 days after sowing. The samples were separately allocated and subjected to drying in a forced air circulation oven, at a temperature of 70ºC, until a constant mass was obtained. The dry mass was measured on a precision scale and the results were expressed as mg seedling^{-1}.

Experiment II

This work was carried out in 2014 in the experimental area located at latitude 31º52 'S, longitude 52º21' W and altitude 13 m, in a region of temperate climate and well distributed rains of the *Cfa* type according to Köppen. The evaluation of the physiological quality of the seeds was carried out in the Laboratory of Seed Analysis of the Department of Phytotechnics, Postgraduate Program in Seed Science and Technology, Federal University of Pelotas.

BRS Umbu wheat seeds produced by the plants of experiment I, submitted to different cutting managements were used. The sowing was carried out in polyethylene pots, containing substrate, soil of the A1 horizon of a Solodic Eutrophic HaplicPlanosol, belonging to the Pelotas mapping unit. The correction of soil fertility was based on chemical analysis according to the Manual of Fertilization and Liming for the States of Rio Grande do Sul and Santa Catarina (CQFS RS/SC, 2004). The control of insects and diseases was also carried out in a preventive manner according to the recommendation of the crop.

Measured characters

The evaluation of the yield characters was carried out in ten plants randomly collected per experimental unit, being determined: the seed mass per cob (SMC), number of cobs per plant (NCP), thousand seed weight (TSW). The physiological characteristics evaluated were germination (G), first germination count (FGC), shoot dry mass (SDM) and root dry mass (RDM), using the same methodology as experiment I.

Statistical analysis

The data were submitted to the assumptions, then the analysis of variance was performed by the F test at 5% of probability, in order to reveal the interaction between cutting managements and crops, the variables that showed significant interaction were dismembered to the simple effects at 5% of probability. The variables that did not show interaction were dismembered to the main effects and compared by the Tukey test at 5% of probability.

RESULTS AND DISCUSSION

Experiment I

It is observed that in the crop 1, the seeds from the plants with cut absence and first cut obtained greater germination, similar to the one occurring in crop 2, where the first cut management obtained higher magnitude for germination (Table 1). Rodolfo et al., (2017) did not find significant difference for the percentage character of germination, however, they concluded that plants submitted to the largest numbers of cuts present less vigor. The germination can be influenced by different environmental factors, some related to the permanence of the seed in the field, the harvest or even the occurrence of environmental stresses.

The first germination count (FGC) of the seeds of the crop 1, coming from plants in the absence of cutting and in the crop 2 for the first cut, obtained higher magnitudes in the FGC (Table 1). According to Carletto et al. (2015), BRS Umbu dual-purpose wheat genotype is influenced by cuts and is not recommended for the second cut. The response between crops may be related to the climatic conditions of each year, since they exert influence on the physiological quality of the seeds produced (Seixas et al., 2004). On the other hand, the first germination count can be considered as an indicator of vigor, which is also influenced by both the environment and the physiological and structural conditions of the plant.

Table 1: Averages for interaction of the BRS Umbu dual purpose genotype x cutting management, for the germination (G) and first germination count (FGC) variables, in the municipality of Frederico Westphalen in two agricultural crops.

	G (%)		FGC (%)	
Cutting managements	Crop1	Crop2	Crop1	Crop2
Absenceofcut	95 a A	92 b A	95 a A	86 c B
Firstcut	90 a B	98 a B	71 c B	94ab A
Secondcut	84 b B	91 b A	84 b A	88 bc A
Thirdcut	91 a A	83 c B	91 a A	77 d B
CV(%)	3,809		14,280	

*Averages followed by the same capital letter in the line do not statistically differ for Tukey for the cut systems with 5.00% of probability. **Averages followed by the same lowercase letter in the column do not statistically differ for Tukey for agricultural crops at 5.00% of probability.

For the thousand seed weight (TSW), it can be observed that the seeds from plants with no cut and one cut showed superiority in both crops (Table 2). The observed response may be related to the fact that some forage species respond to cutting management more efficiently or even improve their photosynthetic capacity (Costa, 2004). Similar results were observed by Martin et al. (2010) and Carletto et al. (2015) where they showed a greater thousand seed weight in the management with absence of cut and first cut in double purpose wheat. Rodolfo et al. (2016) verified that this genotype tends to decrease the thousand seed weight when submitted to the cut. It is important to note that the adequate leaf area may favor the radiant energy capture process and, together with the plant architecture, favor the production of carbohydrates, soluble proteins, starch, and mobilize these reserves to the seeds and thus influence seedling performance (Henning, et al., 2010).

Regarding the seedling dry mass (DM), it can be observed in table 2 that in the crop 1, those coming from the management constituted by absence of cut and second cut were superior. However, in crop 2 the seedlings from the managements absence of cut and first cut showed superiority. The seedling dry mass may be related to the amount of reserves, as well as to the one thousand seed weight and the efficiency of metabolization and growth rate allocation (Falqueto et al., 2009).

Table 2: Averages for interaction of the BRS Umbu dual purpose wheat genotype x cutting managements, for the variables one thousand seed weight (TSW) and seedling dry mass (DM), in the municipality of Frederico Westphalen in crops 1 and 2.

	TSW (g)		DM (g)	
Cutting managements	Crop1	Crop2	Crop1	Crop2
Absenceofcut	29,51 a A	30,93 a A	0,11aA	0,13aA
Firstcut	26,72 a A	27,86 a A	0,09bB	0,11aA
Secondcut	24,96ab A	20,04 b B	0,12 aA	0,04bB
Thirdcut	21,21 b A	12,19 c B	0,10abA	0,05bB
(CV%)	12,975		14,280	

*Averages followed by the same capital letter in the line do not statistically differ for Tukey for the cut systems with 5.00% of probability. **Averages followed by the same lowercase letter in the column do not statistically differ for Tukey for agricultural crops at 5.00% of probability.

For the seed mass per cob (SMC) higher magnitude was observed for the absence of cut management (Table 3). This result can be related to the cuts, because the reduction of the number of leaves influences in the reduction of the biomass and remobilization of assimilates of the stem (Gondim et al., 2008). Carvalho et al. (2015), when evaluating the correlations among morphological traits and components of dual-purpose wheat production, observed the influence of cut management on tillers' stem diameter and the effects correlated to seed mass per cob.

Table 3. Environments averages for the BRS Umbu dual purpose wheat genotype x cutting managements, for the seed mass per cob (SMC) variables, in the municipality of Frederico Westphalen in crops 1 and 2.

	SMC (g)
Cutting managements	Crops average
Absence of cut	0,94 a
First cut	0,78ab
Second cut	0,57 b
Third cut	0,20 c
(CV%)	29

*Averages followed by the same lowercase letter in the column do not statistically differ for Tukey for agricultural crops at 5.00% of probability.

When comparing SMC among the agricultural crops it was verified that the seedlings of the crop 1 showed superiority to those of the crop 2 (Table 4). Each genotype has its peculiarities, which causes it to respond differently to the loss of the leaf area with photosynthetic capacity (Bortolini et al., 2004), especially when submitted to different environmental conditions.

Experiment II

When checking the effect of the cuts on subsequent generation, it was observed that the BRS Umbu genotype did not express interference from the number of cuts in the first germination count (FGC), germination (G), shoot dry mass (SDM) and root dry mass (RDM) (Table 5).

Table 4. Seed mass per cob (SMC) averages among environments for the BRS Umbu dual purpose wheat genotype x cutting managements in the municipality of Frederico Westphalen in crops 1 and 2.

	SMC (g)
Crop 1	0,79 a
Crop 2	0,46 b
(CV%)	29

*Averages followed by the same lowercase letter in the column do not statistically differ for Tukey for agricultural crops at 5.00% of probability.

Table 5. Averages for first germination count (FGC), germination (G), shoot dry mass (SDM), root dry mass (RDM) for BRS Umbu dual purpose wheat genotype x cutting managements in the municipality of Pelotas in 2014.

Cutting managements	G (%)	FGC (%)	SDM (mg)	RDM (mg)
Absence of cut	96 a	84 a	0,11 a	0,08 a
First cut	94 a	77 a	0,11 a	0,08 a
Secondcut	96 a	81 a	0,11 a	0,09 a
Thirdcut	93 a	82 a	0,12 a	0,09 a
CV(%)	4,19	4,82	10,55	0,24

*Averages followed by the same lowercase letter in the column do not statistically differ for Tukey for agricultural crops at 5.00% of probability.

For the number of cobs per plant (NCP), one thousand seed weight (TSW), seed mass per cob (SMC), where the subsequent generation is affected by cutting managements (Table 6). Plants submitted to the third cut presented a reduction to the NCP and SMC and showed that the greater number of cuts negatively affects the yield components (Martin et al., 2010).

Table 6. Averages for number of cobs per plant (NCP), one thousand seed weight (TSW), seed mass per cob (SMC) for the BRS Umbu dual purpose wheat genotype x cutting managements in the municipality of Pelotas in 2014.

Cutting managements	NCP (g)	TSW (g)	SMC (g)
Absence of cut	10,16ab	0,27 b	8,18ab
First cut	9,67 b	0,31 a	9,18ab
Second cut	14,0 a	0,34 a	12,31 a
Thirdcut	9,33 b	0,31 a	7,47 b
CV(%)	13,81	4,41	18,10

*Averages followed by the same lowercase letter in the column do not statistically differ for Tukey for agricultural crops at 5.00% of probability.

As for the thousand seed weight (TSW), plants under the absence of cutting present seeds with lower mass. This variable is influenced by the leaf area available for photosynthesis, layout and leaf format and number of fertile tillers, as well as, it had relation with the genotype. Plants with absence of cuttings present greater accumulation of total dry mass and in the stem, which presents negative relation with the thousand seed weight (Muller et al., 2012).

CONCLUSIONS

The cutting managements affect the components of yield, where thousand seed weight and seed mass per cob, as well as germination, first germination count and seedling dry mass of dual purpose wheat.

In the generation that evaluates the quality of the seeds produced, the cuts do not influence the physiological quality of the seeds; however, they affect the yield components, number of cobs per plant, one thousand seed weight and seed mass per cob.

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